# Math 365 Syllabus

Instructor: Anastassia Etropolski
E-mail: aetropolski@rice.edu
Office: HBH 412
Class Time: MWF 1:00 - 1:50
Classroom: HBH 427
Office Hours: M 10:30 - 12, Th 2:30 - 4
Main Text: Elementary Number Theory: Primes, Congruences, and Secrets

## Course Description & Aims

Number Theory can be described as the study of patterns in the integers. What makes it beautiful and difficult is that understanding and proving these patterns often takes one on a journey through all areas of mathematics. We will begin with the deceptively simple problem of factoring integers and understanding divisibility. This will bring us naturally to the definition of modular arithmetic, which is a tool that greatly simplifies a lot of calculations. In particular, we will take advantage of it to understand public-key cryptography and what makes it work.

You will see that with the language of modular arithmetic, many interesting and difficult questions naturally arise. This will naturally lead us onto more technical subjects, such as quadratic reciprocity, and toward the end of the semester we will talk a bit about algebraic number theory. Remember imaginary numbers? Believe it or not, those will come back to play a big role in understanding regular old integers!

In addition to learning the mathematical material, you will also learn to do some coding in `Sage`, an open-source mathematics software package. You will not need to install anything on your computer, as it has a cloud-based interface, nor do I expect you to have any coding experience. This will simply be a tool for exploring the integers and for making the computations palatable.

Finally, I am aware that there will be students at varying levels in this course. Some of you have no experience with proofs and some have already taken proofs-based courses. Parts of the course will focus on proof techniques and may be elementary to some, but there is something for everyone to learn. As my number theory professor in undergrad told us, there's nothing elementary about elementary number theory.

Here is an incomplete list of topics we will cover: divisibility, the Euclidean algorithm, the ring of integers modulo $n$, the Chinese remainder theorem, primality testing, public-key cryptography, quadratic reciprocity, the Gaussian integers, and Euclidean domains.

## Expectations

Students are expected to read the text and look over their notes before each class. My goal is to guide you through the subject and provide gentle nudges, but I hope you will find the fun in exploring the subject on your own. By having the material fresh in your mind before each class, you will be better able to participate and get the most out of the hour (er, 50 minutes). You are encouraged to speak up in class without fear of saying something wrong, because mistakes are simply an opportunity to learn the subject better. As you will see, plenty of great mathematicians have made mistakes in this subject, so you are in good company.

## Text

The main text we will be using is Elementary Number Theory: Primes, Congruences, and Secrets by William Stein. It is available for free on his website here:

`http://wstein.org/ent/ent.pdf`

This will be supplemented by other online material, which will be posted on the course website. I highly encourage you to read each section we cover, as I went out of my way to choose a book with wonderful exposition. It is very easy to follow and full of great examples.

## Website

The course webpage can be found here:

`http://math.rice.edu/~ae22/365F16.html`

I will post homework assignments, reading assignments, and exams on the website, as well as a detailed syllabus of which topics we will be covering as the semester progresses.

## Homework

Homework will be assigned/collected on a weekly basis. You are encouraged to work together to solve the problems, but you are expected to turn in your own work. **Do not search the internet for solutions to the homework**. This will only cheat you out of a learning opportunity. If you are completely stuck, you should either e-mail me or come to my office hours. See the office hours section below.

Some of the problems will be proof-based and therefore written, while others will be done in `Sage`. The written work should be handed in (or e-mailed if you use LaTeX), but the code can simply be shared online before the deadline. I will give more explicit instructions when the time comes. You are encouraged to correct your homework once it is returned and turn it in to me to improve your grade.

## The Sage Cloud

Each student will be required to create an account on the SageMathCloud, which can be found here:

`https://cloud.sagemath.com/`

It is completely free to use, so if at any point you see something asking you for money, ignore it. When a homework assignment or exam asks you to turn in something in `Sage`, you will simply make a new project and share it with the grader and myself. More information on how to do this will be provided. All assignments will be due at 11:59pm on the date in question unless otherwise noted, but I urge you not to leave it for the last minute as the internet is a cruel mistress, and servers crash sometimes.

You may of course peruse the `Sage` documentation or `Sage` tutorials if you are having trouble figuring out the syntax, but you should not be searching the internet for solutions to the assignments. When in doubt, shoot me an e-mail and I will do my best to help.

## Exams

There will be two midterm exams and a final exam in this class. All of the exams will be take-home and open-book (but not open-internet). You may only use your notes and any texts I've provided as reference, and you may not work on the problems with anyone else.

## Grading Policy

The grading scheme is as follows:

Homework: 35% Midterm Exams: 40% (20% each) Final Exam: 25%

Notice that your homework grade is a substantial portion of your grade. Please take advantage of the opportunity to make corrections to your homework.

## Course policies & resources

*Attendance:* You are expected to attend class every day, however there is no penalty for absences.

*Honor Code:* Students are expected to abide by the Rice Honor Code when working on homework and exams. As stated earlier, collaboration with other students is encouraged on homework, but is not allowed

on exams. You are expected to only consult the text, your notes, and/or extra material posted to the course website.

*Office Hours:* My office hours are designed to be a time when any student can feel free to come by to talk with me about the course. You do not need to inform me that you are coming, and you do not even need to have specific questions ready for me to answer. For example, you should feel free to come by if you want some designated time to work on homework problems, if you had trouble following a lecture, or if you want to go over specific topics that you had trouble with.

If you cannot make it to my office hours, feel free to e-mail me to set up a time to meet, or just e-mail me your questions. I will respond as soon as I get a chance, and I prefer you come to me with your questions rather than scouring the internet for the solution.

*Student Accommodations:* If you have a documented disability that may affect academic performance, you should: 1) make sure this documentation is on file with Disability Support Services (Allen Center, Room 111 / adarice@rice.edu / x5841) to determine the accommodations you need; and 2) meet with me to discuss your accommodation needs.